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Completing Below-Ground Carbon Budgets for Pastures, Recovering Forests, and Mature Forests of Amazonia

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Research Progress:

Davidson visited the research site at Paragominas, Brazil, in August 1993. The first purpose of this trip was to begin training a Brazilian technician to conduct monthly soil respiration measurements. Nepstad visited the research site in November, 1993, and Trumbore visited in February, 1994, to continue the training process.

Another purpose of Davidson's trip in August was to obtain some data on soil radon profiles that our previous research at the site indicated were necessary to complete a manuscript on the depth distribution of CO_2 production in soil. Since the August trip, Davidson and Trumbore have completed a manuscript that is currently under review by colleagues and that should be submitted for publication in the near future. The manuscript describes how profiles of radon and CO_2 can be used to estimate at what depth the CO_2 is being produced. This information is important for determining the importance of deep roots as sources of carbon inputs in these soils.

During Nepstad's trip to the research site in November 1993 more data were collected of root biomass and on root decomposition studies. We are now beginning to use these new root data in our model of soil C turnover, which is the subject of another paper currently being drafted by Trumbore.

During Trumbore's trip, new soil access tubes were installed in a secondary forest and a managed pasture. A WHRC research technician, Paul Lefebvre, is now (late May, 1994) at the site installing more tubes at more secondary forest and managed pasture sites. Soil gases will be analyzed for CO_2 and $^{14}CO_2$, and soil organic matter will be analyzed for ^{14}C. This effort will allow us to expand our study to these land use types, as outlined in our proposal.

Nepstad has also visited two new research sites: Santana de Araguaia is to the southeast of Paragominas near the forest-savanna transition where precipitation is lower than Paragominas; Trombetas is to the northwest of Paragominas and has somewhat higher precipitation that Paragominas. Deep soil pits have been dug, soil moisture sensors have been installed, and samples have been removed for measuring root biomass.

A Brazilian student, Gustavo Hees Negreiros, has been working on a geographic information system (GIS) of the Amazon basin which includes data layers on soils and precipitation. Recently, estimates of soil texture from the RADAMBRASIL database have been used to calculate potential soil water storage. These estimates have been merged with climate data to calculate soil water extraction by forest canopies during the dry season. A preliminary map of the areas where deep roots are needed for extracting deep soil water has been produced.

Future research:

The research tasks to be included in the coming year include:
1. measuring dissolved organic carbon (DOC) throughout the soil profile and estimating rates of C input into deep soils via this pathway.
2. year-round monthly soil CO_2 flux measurements in four ecosystems: primary forest, secondary forest, managed pasture, and degraded pasture.
3. modeling of soil C dynamics in all four ecosystems.
4. year-round monitoring of soil moisture dynamics at the new research sites at Santana de Araguaria and Trombetos.
5. expansion of the study to a site near Manuas, where precipitation is less seasonal than at Paragominas.

Manuscripts in press:

Nepstad, Jipp, Moutinho, Negreiros, and Vieira. The loss and recovery of forest health in seasonally-dry Amazonia: canopy seasonality, biomass and ants. In Rapport (Ed.) Monitoring and Evaluation of Major Ecosystem Health, NATO_ARS Series, Springer-Verlag, in press.

Manuscripts submitted:

Nepstad, Carvalho, Davidson, Jipp, Lefebvre, Negreiros, Silva, Stone, Trumbore, and Vieira. The deep soil link between water and carbon cycles of Amazonian forests and pastures. Nature.

Manuscripts in preparation:

Davidson and Trumbore. Production of CO_2 in deep soils of the eastern Amazon. Tellus.

Trumbore, Davidson, and Nepstad. A below-ground budget of carbon cycling in forests and pastures of the eastern Amazon. Global Biogeochemical Cycles.

Camargo, Martinelli, Trumbore, and Nepstad. Carbon turnover in forest and pasture soils of the eastern Amazon estimated from ^{13}C and ^{14}C. Plant and Soil.

Nepstad, Vieira, Jipp, de Carvalho. Canopy dynamics, root distribution and soil water uptake in deeply-rooting forest and pasture, eastern Amazonia. Oecologia.

Carvalheiro, K. and D. Nepstad. Deep-soil heterogeneity and fine root distribution in Amazonian forest, pasture and secondary forest. J. Tropical Ecology.

Nepstad, D. Fine root biomass and decomposition to 6 m depth in Amazonian forest, pasture and secondary forest. Plant and Soil.

Nepstad, D., L. Martinelli, P. Camargo, S. Trumbore, E. Davidson, C. Uhl. Complete carbon stocks in forest, pasture and secondary forest, eastern Amazonia.

Negreiros, G., D. Nepstad, E. Davidson, P. Lefebvre, T. Stone. Canopy seasonality, available soil water, and the predicted distribution of deep-rooted, evergreen forests in Brazilian Amazonia. Global Biogeochemical Cycles

Papers presented (or submitted for presentation) at professional meetings:

Ecological Society of America, 1994 Annual Meeting, Knoxville TN:

Davidson et al. Soil carbon dynamics in forests and pastures of the eastern Amazon.

Nepstad et al. Canopy water relations and leaf phenology in deep-rooted forest and pasture, eastern Amazonia.

First GCTE Science Conference, May 1994, Woods Hole, MA:

Davidson et al. Soil carbon dynamics in forests and pastures of the eastern Amazon.

Nepstad et al. Soil water extraction, canopy seasonality, and drought-stress in deep rooted primary forest, pasture and secondary forest, east Amazonia.

American Geophysical Union, Fall Meeting, 1993, San Fransicso:

Trumbore et al. Prediction of CO_2 in pasture and mature forest soils of eastern Amazonia.

Camargo et al. $\Delta^{14}C$, $\delta^{13}C$ and C inventory differences between forest and pasture in soils of eastern Amazonia.

International Symposium on Resource and Environmental Monitoring, Sept., 1994, Rio de Janeiro:

Negreiros et al. The distribution of evergreen forests in seasonally-dry Amazonia.

Lefebvre and Stone. Monitoring selected logging in eastern Brazilian Amazonia using multi-temporal Landsat Thematic Mapper imagery.